Space Weather Technical Forecast

Issued on Saturday, 31 December 2022 at 00:55 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of isolated G1/Minor Geomagnetic Storms initially day 1 (31st), Chance of further M-flares throughout. Chance of Active High Energy Electron Fluence by day 2 (1st)

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar Activity has been Moderate in the past 24 hours with two M-flares, both originating from AR3176, and the largest of which was an M3 flare at 30/1838 UTC. There are currently 8 numbered active regions on the visible disc, the largest of which is AR3176 (Esi/Beta-gamma) in the northeast quadrant. The other most noteworthy regions are AR3180 which is still emerging around the northeast limb, and has been tentatively analysed as Cao/Beta at present. This region gave an M2 flare on the UTC evening of 29th; AR3179 (Dai/Beta), located in the northwest quadrant and which continues to show growth, but has been relatively inactive; and AR3177 (Dsi/Beta) in the southeast quadrant, which is a moderately large group showing some slight growth, again largely inactive at present.

Coronagraph imagery from STEREO-A imagery indicates a CME was associated with the M1 flare at 30/1528 UTC from AR3176. Further imagery is awaited to analyse the CME and any potential Earth-directed component.

Solar Wind / Geomagnetic Activity: Solar winds, as observed by ACE and DSCOVR were indicative of coronal hole connection, rising rather erratically from around 500km/s to around 600km/s. The density was mainly near average. Total Interplanetary Magnetic Field (IMF), Bt, was at mostly Moderate levels, peak around 12nT, but has dropped to weak levels in recent hours. The north-south component, Bz, was often negative and fluctuated between +/-10 nT, before also becoming less disturbed in recent hours. Phi angle was predominantly positive (towards the Sun). Geomagnetic activity was mostly Active (Kp 4), with NOAA/SWPC and Potsdam recording a G1/Minor Storm interval 30/0000-0300 UTC.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) as measured at GOES16 remained at background levels. High energy electron flux (greater than 2MeV) was at mostly Moderate to High levels, with a peak of 3680pfu at 30/1510 UTC. The 24-hour integrated electron fluence remained below the Active threshold on a mostly steady trend. The observed fluence at 31/0000 UTC was 7.42e7 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate activity is expected, with an ongoing daily chance of M-flares. There is a slight chance of X-class flares.

Solar Wind / Geomagnetic Activity: There are currently no Earth-directed CMEs expected to arrive during the forecast period. However, further coronagraph imagery is awaited to analyse a CME that appeared to be associated with the M1 flare at 30/1528 UTC from AR3176, and any potential Earth-directed component.

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The ongoing coronal hole influence is expected to continue on day 1 (31st), before gradually declining days 2 and 3 (1st and 2nd). No further coronal hole enhancements are expected during the forecast period.

Initially Unsettled to Active geomagnetic activity, with a chance of isolated G1/Minor Storm intervals, are expected to gradually ease to be Quiet to Unsettled, with a chance of Active period by day 2 (1st) and mainly Quiet with isolated Unsettled intervals day 3 (2nd).

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux observed by GOES-16 is expected to remain at Background levels throughout but with a chance of rising alongside any notable flares, giving a very slight chance of exceeding the S1/Minor Storm threshold. High energy electron flux (greater than 2MeV) observed by GOES-16 is likely to be Moderate to High levels, with a probable upward trend over the next couple of days. The associated 24 hour fluence will then respond, likely approaching/exceeding the Active (1e8 integrated pfu) threshold days 2 and 3 (1st and 2nd), with a chance of rising above this level by the end of day 1 (31st).

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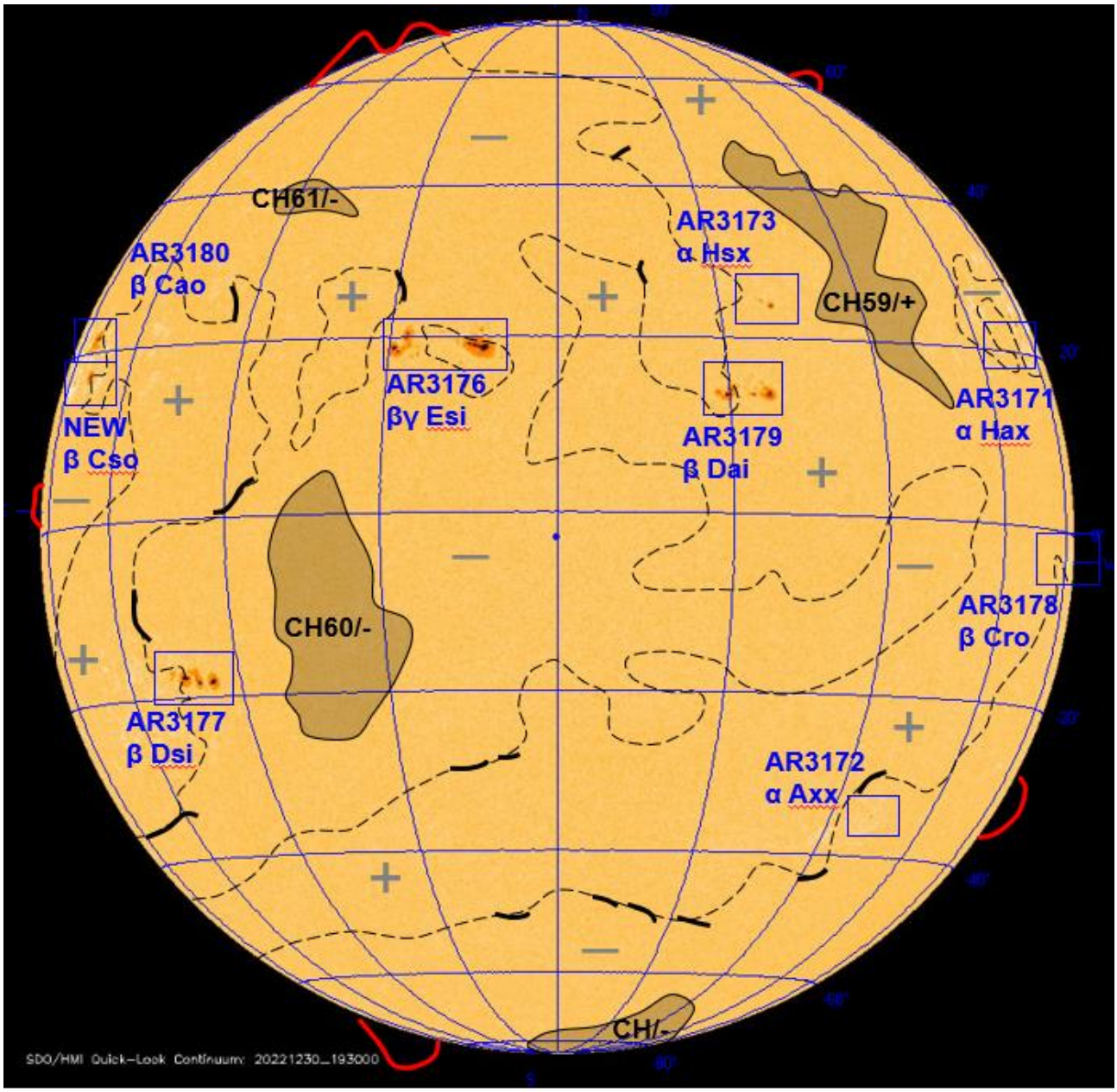
Figure 1. Solar Analysis Valid 30/2000 UTC.



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Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are currently no Earth-directed CMEs expected to arrive during the forecast period. However, further coronagraph imagery is awaited to analyse a CME that appeared to be associated with the M1 flare at 30/1528 UTC from AR3176, and any potential Earth-directed component.

Solar winds are elevated following connection with CH59/+, this may have also been enhanced by a glancing influence from a CME which left the Sun on the 25th, and was expected to pass ahead of the Earth on the 29th. The ongoing coronal hole influence is expected to continue on day 1 (31st), before gradually declining days 2 and 3 (1st and 2nd), with good confidence for MOSWOC enlil expectations. No further coronal hole enhancements are expected during the forecast period.

Initially Unsettled to Active geomagnetic activity, with a chance of isolated G1/Minor Storm intervals, are expected to gradually ease to be Quiet to Unsettled, with a chance of Active period by day 2 (1st) and mainly Quiet with isolated Unsettled intervals day 3 (2nd).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	30	5	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

None expected.

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Radio Blackouts - X-Ray Flares:

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Ex-regions 3160 and 3165 may also return around the eastern horizon in the next couple of days.

Solar Activity is expected to be Moderate to Low with an ongoing chance of M-flares and a very slight chance of X-flares.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	50	50	50	50
Very Active	R3 to R5 X Class	No	5	5	5	5

Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) measured by GOES-16 is at Background levels. Any significant flares will bring a risk of proton flux rising at points during the period, with a slight chance of exceeding the S1/Minor Storm threshold.

Radiation Storms	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	5	5	5	5
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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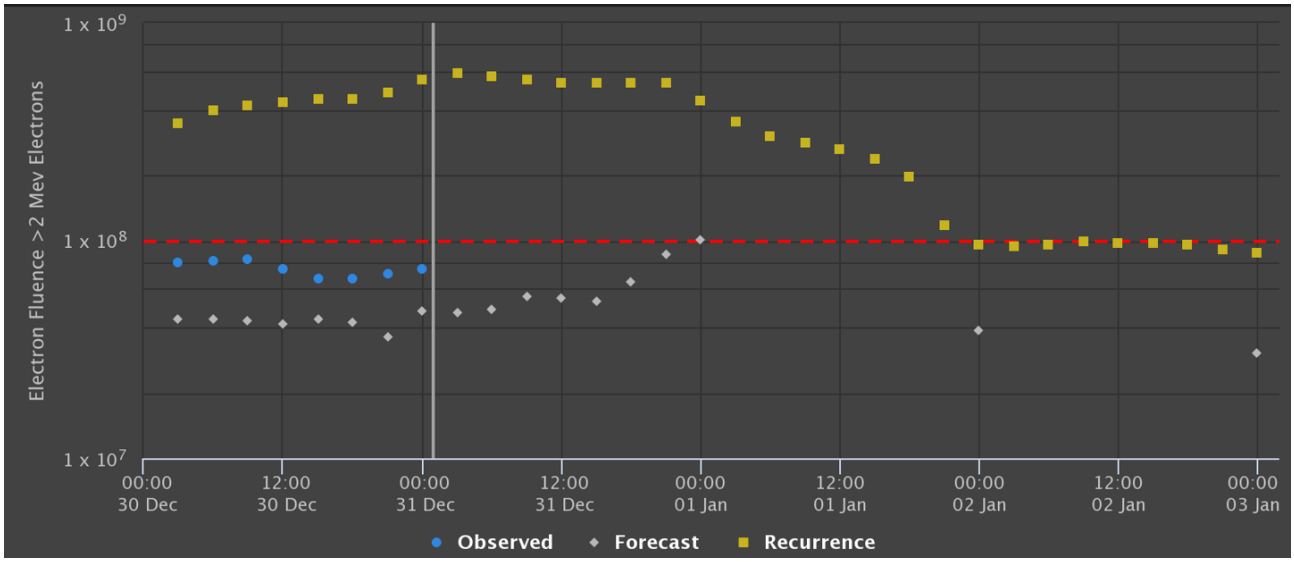
High Energy Electrons Event (≥ 2MeV):

High energy (greater than 2 MeV) electron flux as observed by GOES-16 was at mostly Moderate to High levels, with a peak of 3680pfu at 30/1510 UTC. Flux is likely to trend upwards through days 1 and 2 (31st and 1st), perhaps becoming predominately High for a time before gradually subsiding later in the period.

The associated 24 hour fluence is expected to rise in response, approaching, and likely exceeding the Active (1e8 integrated pfu) threshold on days 2 and 3 (1st and 2nd), with a chance of rising above this level by the end of day 1 (31st). REFM has yet to respond to the recent fast wind enhancement, so is currently giving poor guidance to expected fluence.

GEO Electron Environment	Level ($cm^{-2}\ sr^{-1}\ day^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	40	60	50	30
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 2: MOSWOC REFM latest output.



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